

these values as a reference to assist troubleshooting, *e.g.*, by a system administrator or by automated troubleshooting routines within a storage management processing engine or other processing engine. It is also possible that estimated values of average access time AA' and average transfer rate TR' may be saved in meta data block format on the disk so that a record is maintained of the last test period, preventing re-testing of the disk at each re-boot and therefore saving re-boot time. Further, it will be understood that the above 32KB and 64KB block size values are exemplary only, and that pairs of block sizes using one of these or using entirely different values (*e.g.*, 64KB and 128KB, 32KB and 128KB, 64KB and 512KB, *etc.*) may be set or selected as desired to solve equation 31 for two unknowns in the manner given above.

### EXAMPLES

The following examples are illustrative and should not be construed as limiting the scope of the invention or claims thereof.

#### Examples 1-6

The following examples present data obtained from one embodiment of a simple resource model according to the disclosed methods and systems. For these examples, it is assumed that total available memory is allocated for buffering and no cache is supported. These examples consider only storage processor capacity for video data retrieving and do not take into account any front-end bandwidth constraints.

Table 1 summarizes various assumptions and setting used in each of examples 1-6. For all examples it is assumed that NoD = 5 disk drives with 10,000 RPM capacity. Values of AA and TR performance characteristic data was obtained for a "SEAGATE X10" disk drive by I/O meter testing. A Skew distribution of 1.1 is assumed with no buffer sharing (*e.g.*, B\_Save = 0), and 10% of the cycle T is reserved for other disk access activities (Reserved\_Factor = 0.1). Calculations were made for three different playback rates:  $P_i = 20$  kbps,  $P_i = 500$  kbps and  $P_i = 1$

mbps, and for two different buffer space sizes:  $B_{\max} = 1$  Gbyte and  $B_{\max} = 1.5$  Gbyte. Double buffering is assumed, and thus the value of Buffer\_Multiplicity = 2.

**Table 1 -- Assumptions and Settings**

Exam. No.	P (kbps)	B (Gbyte)	Buf_Mult	AA (ms)	TR (kBps)	NoD	Skew	Reserved_Factor	B_Save	T Max (Sec)	NoV Max
1	20	1	2	8.6	23364.85	5	1.1	0.1	0	22.54	8373
2	20	1.5	2	8.6	23364.85	5	1.1	0.1	0	28.37	9976
3	500	1	2	8.6	23364.85	5	1.1	0.1	0	7.153	1055
4	500	1.5	2	8.6	23364.85	5	1.1	0.1	0	9.82	1152
5	1024	1	2	8.6	23364.85	5	1.1	0.1	0	6.17	595
6	1024	1.5	2	8.6	23364.85	5	1.1	0.1	0	8.67	632

FIGS. 5-7 illustrate lower bounds and upper bounds of cycle time T plotted as a function of NoV for buffer size of 1 Gbyte and each of the three playback rates (i.e., 20 kbps, 500 kbps and 1024 kbps) for Examples 1, 3 and 5 respectively using the following relationships from Resource Model Equation (18):

For lower bound:

$$T = (Skew/NoD) * NoV * AA / \{ (1 - Reserved\_Factor - (Skew/NoD) * (\sum_{i=1}^{Nov} P_i) / TR) \};$$

For upper bound:

$$T = \{ (1 - Reserved\_Factor) * B_{\max} / \{ Buffer\_Multiplicity * [(1 - B\_Save) * (\sum_{i=1}^{Nov} P_i)] \} \}.$$

As may be seen from each plot of FIGS. 5-7, it is possible to find where the lower bound curve intercepts the upper bound curve. This interception point may be used to provide two useful values: the maximal number of viewers NoV a storage subsystem may support, and the

optimal cycle Time T in which both the I/O capacity and the buffer space are fully utilized. These values are also given in Table 1.

The following observations may be made based on the data of examples 1-6. First, the total system capacity is a balance of several operational characteristics. For example, increasing the buffer space from 1 Gbyte to 1.5 Gbyte (a 50% increment), does not increase the number of viewers the system can support proportionally. Instead, the number of viewers increases by a smaller percentage. Thus, unilaterally increasing buffer space without incrementing I/O capacity, or vice-versa may not achieve optimum system performance. Further, implementing an integrated cache/buffer structure may be more effective to improve system performance than increasing buffer space and/or I/O capacity.

Second, considering front-end bandwidth constraint against the above results, it may be seen that the front-end bandwidth of 500 mbps will reduce the information management system I/O capacity more severely in high client bandwidth cases than in lower client bandwidth cases. For example, where the consumption rate is 20 kbps and the available buffer is 1.5 Gbyte, an information management system can support approximately 10,000 viewers from 5 disk drives, which presents about 197 mbps of front end throughput. On the other hand, where the consumption rate is 1 mbps and the available buffer is 1 Gbyte, then the information management system can support 600 viewers from 5 disk drives, which presents 600 mbps front end throughput, which already exceeds the designated front end bandwidth.

#### Examples 7-10

The following hypothetical examples illustrate six exemplary use scenarios that may be implemented utilizing one or more embodiments the disclosed methods and systems.

##### *Example 7 --- Low Bandwidth Video-on-Demand Scenario*